

REMARKS/ARGUMENTS

The amendment to Claim 18 was discussed at the interview, and is supported at specification page 5, lines 27-30. In this regard, the Examiner's suggestion has been taken, and the term "latex" has been used in the claims. New Claims 26-30 are supported at specification page 3, bottom, by the paragraph bridging pages 5 and 6, and by the list of basic agents at page 4, line 5 – page 5, line 6. No new matter has been entered.

Applicants would like to thank Examiner Egwim for the helpful and courteous interview held January 25, 2005. As discussed at the interview, the present invention "aqueous dispersion" of halogenated vinyl polymers is defined at specification page 5 as a latex, and is a dispersion of polymer in water obtained after radical aqueous emulsion polymerization. In discussing this specification definition with the Examiner, it was agreed that this definition would be imported into the claims so as to make even more explicit their meaning. In this regard, this amendment is not a narrowing amendment, but one that simply clarifies the claim in a manner such that the reader does not have to refer back to the specification description for a particular definition of the term "aqueous dispersion."

As also discussed during the interview, the prior art references applied against the claims are directed to suspension polymerization, not emulsion polymerization. Applicants attach hereto an excerpt from the Kirk-Othmer Encyclopedia of Chemical Technology explaining some of the basic differences between emulsion and suspension polymerization, all well known to the Examiner. Suspension polymerization produces particles that are quite different from those prepared by emulsion polymerization, due at least in part to the fact that suspension polymerization relies upon mechanical techniques in suspending particles while emulsion polymerization relies in part on chemical factors. In this regard it was agreed during the interview that the claims, now explicitly pointing out the fact that it is a latex that

is being claimed, are different and distinct from the suspension polymerization products occurring in the prior art.

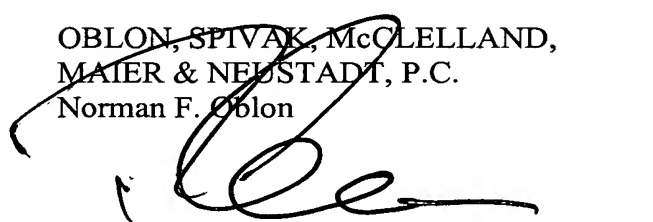
For the Examiner's convenience, it can be confirmed that the primary references applied against the claims clearly relate to suspension polymerization by referring to, for example, column 3, lines 54 ff of Balwe, and column 2, lines 4 ff of Siefeld. The secondary references, McDonald and DE26 03 025, cannot make up for this fundamental difference between the primary references and the claims (the secondary references were cited against Claim 20 (probably intended to be Claim 21) for their discussion of wax).

Accordingly, and in view of the agreements reached during the interview, Applicants respectfully submit that the present application is now in condition for allowance, and early notification to this effect is respectfully requested.

Finally, Applicants request that Claims 24 and 25 be rejoined and allowed along with Claim 18, as Claims 24 and 25 include all the limitations of this allowable independent claim and are thus themselves allowable. These claims provide Applicant with important protection, and there is no need for a separate patent directed to these claims because they depend from Claim 18, which is patentable.

Respectfully submitted,

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ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY

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TO
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less than a second. Thus, high molecular weight polymer is produced right from the beginning; high conversions are not required.

The minimum polydispersity index from a free-radical polymerization is 1.5 if termination is by combination, or 2.0 if chains are terminated by disproportionation and/or transfer. Changes in concentrations and temperature during the reaction can lead to much greater polydispersities, however. These concepts of polymerization reaction engineering have been introduced in more detail elsewhere (6).

Polymerization Processes. Free-radical polymerization is carried out in a variety of ways. One of the practical problems that must be dealt with is runaway reactions which can result from autoacceleration, an increase in rate of polymerization caused by diffusion-limited termination (reduced k_t) at high conversions. The effects of autoacceleration are compounded by large, exothermic heats of polymerization, typically 42–84 kJ/mol (–10 to –20 kcal/mol), and the great increase in polymerization rate with temperature. Also, the low heat capacities and thermal conductivities of organic reaction masses and the very high viscosities of the reaction mass at high conversions limit heat removal and make temperature control difficult.

Bulk Polymerization. This involves only monomer, initiator, and perhaps chain-transfer agent. It gives the greatest polymer yield per unit of reactor volume and a very pure polymer. However, in large-scale batch form, it must be run slowly or in continuous form with a lot of heat-transfer area per unit of conversion to avoid runaway. Objects are conveniently cast to shape using batch bulk polymerization. Poly(methyl methacrylate) glazing sheets are produced by batch bulk polymerization between glass plates. They are also made by continuous bulk polymerization between polished stainless steel belts. Polystyrene and other thermoplastic molding compounds are produced by continuous bulk polymerization processes (6).

Solution Polymerization. In this process an inert solvent is added to the reaction mass. The solvent adds its heat capacity and reduces the viscosity, facilitating convective heat transfer. The solvent can also be refluxed to remove heat. On the other hand, the solvent wastes reactor space and reduces both rate and molecular weight as compared to bulk polymerization. Additional technology is needed to separate the polymer product and to recover and store the solvent. Both batch and continuous processes are used.

Suspension Polymerization. In this process the organic reaction mass is dispersed in the form of droplets 0.01–1 mm in diameter in a continuous aqueous phase. Each droplet is a tiny bulk reactor. Heat is readily transferred from the droplets to the water, which has a large heat capacity and a low viscosity, facilitating heat removal through a cooling jacket.

Agitation is critical to carrying these reactions out successfully. It is used, along with suspending agents in the aqueous phase, to control droplet size and maintain dispersion. If it fails or weakens before the particles become sufficiently rigid (the polymer must be below its T_g), the particles coalesce, leading to a runaway bulk reaction, which not only can be dangerous, but may require the use of mining tools to clear a commercial reactor. For this reason also, it has not been possible to run suspension polymerization continuously, since any flow system has some stagnant corners where polymer would accumulate, nor can

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it be used to produce rubbers. Commercially, the reactions are carried out in jacketed, stainless steel or glass-lined stirred tanks of up to 75.5 m³ (20,000 gal) capacity.

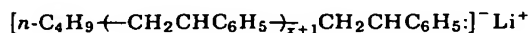
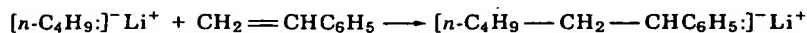
The product of a successful suspension polymerization is small, uniform polymer spheres. For certain applications, they are used directly, eg, as the precursors for ion-exchange resins or bead foams. For others, they may be extruded and chopped to form larger, more easily handled molding pellets.

Emulsion Polymerization. When the U.S. supply of natural rubber from the Far East was cut off in World War II, the emulsion polymerization process was developed to produce synthetic rubber. In this complex process, the organic monomer is emulsified with soap in an aqueous continuous phase. Because of the much smaller ($\leq 0.1 \mu\text{m}$) dispersed particles than in suspension polymerization and the stabilizing action of the soap, a proper emulsion is stable, so agitation is not as critical. In classical emulsion polymerization, a water-soluble initiator is used. This, together with the small particle size, gives rise to very different kinetics (6,21–23).

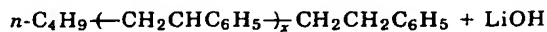
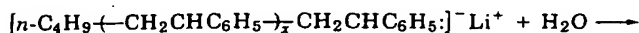
The product of an emulsion polymerization is a latex; ie, polymer particles on the order of 0.5–0.15 μm stabilized by the soap. These form the basis for the popular latex paints. Solid rubber is recovered by coagulating the latex with ionic salts and acids (see LATEX TECHNOLOGY).

The original wartime process was run batchwise in reactors similar to those used for suspension polymerization. Since then, in many plants, the reactors have been hooked together as a series of continuous stirred tanks.

Ionic Polymerization. Anionic Polymerization. Addition polymerization may also be initiated and propagated by anions (23–26), eg, in the polymerization of styrene with *n*-butyllithium. The Li⁺ gegen ion, held electrostatically in



the vicinity of the propagating chain end, can exert a steric influence on the addition of monomer molecules to the chain. Growing chains are terminated immediately by proton-donating impurities, eg, water:



There are some important differences between anionic and free-radical addition. First, unlike free-radical initiators, which decompose and start chains randomly throughout the course of the reaction, anionic initiators ionize readily in fairly polar organic solvents (eg, tetrahydrofuran) or at low concentrations ($< 10^{-4}$ molar) in hydrocarbons, and chains are started immediately, one for each molecule of initiator. Second, in the absence of impurities, there is no termination. Thus, in a batch reactor, all chains are initiated at the same time,

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